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## Avalanche Instability as Nonequilibrium Quantum Criticality

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A fundamental instability in the nonequilibrium conduction band under an electric field bias occurs via the spontaneous emission of coherent phonons. Analytic theory, supported by numerical calculations, establishes that the quantum avalanche, an abrupt nonequilibrium occupation of excited bands, results from the competition between the collapse of the band minimum via the phonon emission and the dephasing of the electron with the environment. The continuous avalanche transition is a quantum phase transition with the nonequilibrium phase diagram determined by the avalanche parameter  $\beta$ . We further confirm the nature of the quantum avalanche with the temperature dependence.

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- [3] J. Nathawat et al, Signatures of hot carriers and hot phonons in the re-entrant metallic and semiconducting states of Moiré-gapped graphene, *Nat. Comm.* 14, 1507 (2023).

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